CLAIMS

1. Recombinant DNA containing a sequence (1) coding for a polypeptide heterologous with respect to a filamentous hemagglutinin of Bordetella (Fha) fused in the same reading frame with a sequence (2) placed upstream from the first, this sequence (2) coding for at least a part of the precursor of the Fha, this part comprising at least the N-terminal region of a truncated mature Fha protein which contains the site of interaction of the Fha with heparin, on the one hand, and which when this latter is itself placed alone under the control of a promoter recognized by the cellular polymerases of B. pertussis and introduced into a B. pertussis cell culture is expressed in this culture under the control of this promoter and excreted in to the culture medium of these cells, on the other.

C 2. Recombinant DNA according to Claim 1, ~~characterized in that~~ wherein the Fha is a Fha of B. pertussis.

A C 3. Recombinant DNA according to Claim 1 ~~or 2,~~ ~~characterized in that~~ wherein the sequence (2) codes for the mature Fha protein.

A C 4. Recombinant DNA according to Claim 1 ~~or 2,~~ ~~characterized in that~~ wherein the sequence (2) results from truncation of the sequence coding for the mature Fha protein on its C-terminal side.

A 5. Recombinant DNA according to ~~any one of the Claims 1 to 4,~~ Claim 1
C ~~characterized in that it comprises additionally~~ further comprising a sequence (3) upstream
C from the sequence (1), this sequence (3) ~~corresponding essentially to~~ consisting essentially of the truncated part of the mature protein, preferably supplemented by the signal sequence of the precursor.

A 6. Recombinant DNA according to ~~any one of the Claims 1 to 4,~~ Claim 1
C ~~characterized in that~~ wherein the sequence (2) comprises the excretion signals of the
C sequence coding for the Fha and the N-terminal domain of Fha homologous to the N-terminal domains of the hemolysins ShlA and HpmA of Serratia marcescens and Proteus mirabilis.

A C 7. Recombinant DNA according to Claim 4 ~~or 6,~~ ~~characterized in that~~ wherein the extension of the sequence (2) towards its C-terminus will not to exceed the length which would cause the transformation of B. pertussis with this recombinant DNA then placed under the control of a promoter capable of being recognized by B. pertussis to no longer permit the direct excretion of the recombinant protein then formed into the culture medium of this B. pertussis.

8. Recombinant DNA according to Claim 6 or 7, characterized in that the sequence (2) extends between the ATG corresponding to the initiation codon for the translation of the Fha to a C-terminal nucleotide beyond nucleotide 907 in the direction of the translation and preferably not beyond the position 6922.

9. Recombinant DNA according to Claim 8, characterized in that it no longer reacts with anti-Fha antibodies more particularly directed against the epitopes of the C-terminal part of the mature Fha, located beyond the nucleotide site 2841 in the sense of translation.

10. Recombinant DNA according to any one of the Claims 1 to 8, characterized in that the polypeptide encoded in the sequence (2) contains at least a specific attachment site of the Fha to the mucosa.

11. Recombinant DNA according to any one of the Claims 1 to 10, characterized in that the sequence (1) codes for a polypeptide having vaccinating properties against a given pathogenic agent.

12. Recombinant DNA according to any one of the Claims 1 to 11, characterized in that it also contains a promoter recognized by the polymerases of a cell transformable with a vector containing the recombinant DNA in question and allowing the expression of the sequences (1) and (2) provided that an accessory gene of the fhaC type is also expressed in this cell.

13. Recombinant DNA according to Claim 12, characterized in that the promoter is a promoter recognized by the polymerases of a bacterium of the Bordetella species, in particular B. pertussis, which in the natural product regulates the expression of the Fha protein.

14. Culture of prokaryotic cells, in particular bacteria, transformed by a recombinant DNA according to Claim 11 or 12, characterized in that the promoter of the recombinant DNA is recognized by the polymerases of said prokaryotic cell.

15. Culture according to Claim 14, characterized in that the cells belong to a Bordetella species, in particular B. pertussis, and that they are also carriers of a fhaC gene expressable in these cells.

16. Culture according to Claim 14, characterized in that the cells belong to a bacterial species other than Bordetella and that they also contain a sequence coding for at least a part of FhaC necessary for the expression of the sequence (2), in a form also expressable within the cells of this culture.

17. Cell culture according to Claim 16, characterized in that its cells belong to the species E. coli.

18. Cell culture according to ~~any one of the Claims 14 to 17, characterized in that~~ the recombinant DNA is incorporated in the chromosomal DNA of said cells.

19. Culture of cells according to ~~any one of the Claims 14 to 18,~~ characterized by the expcsure of the expression product of the sequence (1) at their surface.

20. Culture according to ~~any one of the Claims 14 to 19, characterized in that~~ the sequence (2) contains at least one attachment site for the Fha to the mucosa or to eukaryotic cells, particularly to macrophages or epithelial cells.

21. Cell culture according to Claim 20, characterized in that it is detoxified or attenuated.

22. Immunogenic composition directed against a defined pathogenic agent ~~and characterized in that it contains~~ as active principle cells of the culture according to ~~any one of the Claims 18 to 21~~ in which the sequence (1) codes for an antigen characteristic of this pathogenic agent.

23. Recombinant protein constituted by the expression product of the recombinant DNA according to ~~any one of the Claims 1 to 13.~~

24. Recombinant protein according to Claim 23, characterized by the fact that it comprises at least one of the attachment sites of the Fha protein to the mucosa.

25. Recombinant protein according to Claim 24, characterized in that the expression product of the sequence (1) codes for a polypeptide having vaccinating properties against a given pathogenic agent and in that the expression product of sequence (2) contains an attachment site of the Fha to the mucosa or to eukaryotic cells, particularly macrophages or epithelial cells.

26. Vaccinating composition containing the cell culture of Claim 22 or the recombinant protein of Claim 25, characterized in that it exhibits the mucosal immunogenicity of the Fha, particularly for administration by the nasal route.

27. Process for the production of a recombinant heterologous protein containing a defined polypeptide sequence ~~characterized by~~ the transformation of a culture of prokaryotic cells with a vector containing a recombinant DNA according to ~~any one of the Claims 1 and 6 to 13,~~ said prokaryotic cells also containing a nucleotide sequence coding for FhaC in a form capable of being expressed in it or also having been transformed to

this end, followed by the culture of these cells and the recovery of the product excreted by the cells of this culture into their medium.

28. Process according to Claim 27, ~~characterized in that~~ [wherein] said prokaryotic cells are Bordetella, in particular of the B. pertussis type.

29. Process according Claim 27 ~~or 28,~~ characterized by the additional purification of the excretion product by placing the culture medium in contact with heparin immobilized on an insouble support and by the recovery of the purified recombinant protein by dissociation of the complex which it formed with heparin.